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SNOWSHOE RABBITS AND CONIFERS IN THE WASATCH MOUNTAINS OF UTAH

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Throughout the mountains of Utah the snowshoe rabbit (*Lepus americanus*) is very common, and extensive damage is often noted in natural coniferous stands as well as in plantations made by the Forest Service. It is safe to say that in some of the denser areas of reproduction less than 10 percent of the trees are free from injury, while a fairly large proportion are so severely injured as to be of slight future commercial value. This damage has been studied in some detail in the Wasatch Mountains both in the vicinity of the Cottonwood Nursery on the Wasatch National Forest 25 miles southeast of Salt Lake City and on the Manti National Forest near the Great Basin Experiment Station 10 miles east of Ephraim, Utah.

From the canyon bottoms to the highest elevations at 9,000 to 10,000 feet, wherever there is sufficient food and brush or timber to afford protection, rabbits are present. During the spring and summer they are more or less scattered, but on the approach of winter, after the first few heavy snows, they congregate in the thickets. A person might spend the entire summer in such a locality inhabited by rabbits and not see a single one except occasionally on a road or trail after sundown. The fact, however, that they are present in large numbers may readily be verified by examining a dense clump of tall brush or of timber after there is snow on the ground. Well-beaten trails radiate in all directions. While it is impossible to give an estimate of the number on a given area, it can be stated that as high as 15 were killed in the fall of 1916 on a comparatively narrow strip of dense brush 50 yards wide and about 400 yards long, adjacent to the Cottonwood Nursery. While this did not represent the total number on that particular area it, no doubt, included the majority of them.

The natural enemies of the snowshoe rabbit are the coyote, wild cat, eagle, hawk, owl, and weasel, the former hunting them most persistently. It is reasonably certain that the rabbits will increase as the coyotes decrease and that the injury to conifers will therefore increase. With the destruction of a large number of coyotes on the National Forests the rabbits have had to be controlled, especially in the vicinity of plantations.

The low bushy form, or the entire absence of a definite leader among conifers up to about 8 feet in height, indicate the destructive work of rabbits in eating off the terminal shoot and frequently the top lateral twigs. Trees after reaching a height greater than the maximum depth of the snow (4 to 8 feet), are free from injury, being out of reach of the rabbits. A case of this kind is illustrated in figure 1, where a Douglas fir eaten back repeatedly for 46 years, at last managed to get a leader established beyond the reach of the rabbits and shot up rapidly at once. The growth in the last 14 years has been almost exactly twice the total for the first 46 years. Although ultimate recovery is possible for a large percentage of the trees, especially those reaching a height of 12 inches or over, their future commercial value is frequently reduced. Unfortunately there is no data available to show what percentage of the small reproduction under 12 inches is completely killed by being cut back so severely that recovery is impossible. However, it is known that of all the plantations established on the Big Cottonwood watershed during the last ten years, the injury and loss due to rabbits was very great. In fact, some of the smaller plantations were completely destroyed while the larger ones all suffered more or less severely. It is quite reasonable to assume that the small natural reproduction suffers loss and injury to a similar degree.

During the spring and summer when there is an abundance of herbaceous vegetation and shrubs available for food, the injury to conifers is slight. Sometimes newly established plantations are damaged in summer, possibly due to the succulent nature of the trees fresh from the nursery. The main damage is done during late fall and winter, from the time of the first killing frost when all herbaceous vegetation is destroyed, until the ground becomes bare in the early spring. During this period the food of the rabbits consists almost entirely of the previous season's growth of conifers. As the snow becomes deeper during the winter, covering the smaller trees, the tops of successively taller trees come within reach, until the snow reaches its maximum depth. As the snow melts the smaller trees are again subject to injury.

All of the native conifers including Douglas fir (*Pseudotsuga taxifolia*), white fir (*Abies concolor*), alpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmanni*), limber pine (*Pinus flexilis*), and blue spruce (*Picea parryana*), are subject to damage. In addition, plantations of the following introduced species were more or less severely injured; western yellow pine (*Pinus ponderosa* and *P. ponderosa scopulorum*), lodgepole pine (*Pinus contoria*), Jeffrey pine (*Pinus jeffreyi*), jack pine (*Pinus banksiana*), western white pine (*Pinus monticola*), Norway spruce (*Picea excelsa*), Austrian pine (*Pinus austriaca*), and Scotch pine (*Pinus sylvestris*).

Rabbit injury reduces height-growth to a very marked degree in regions where the animals are plentiful. Table 1 shows the effects of rabbit injury on the height-growth of Douglas fir, white fir, and alpine fir. These data were collected in the vicinity of the Cottonwood Nursery and the Great

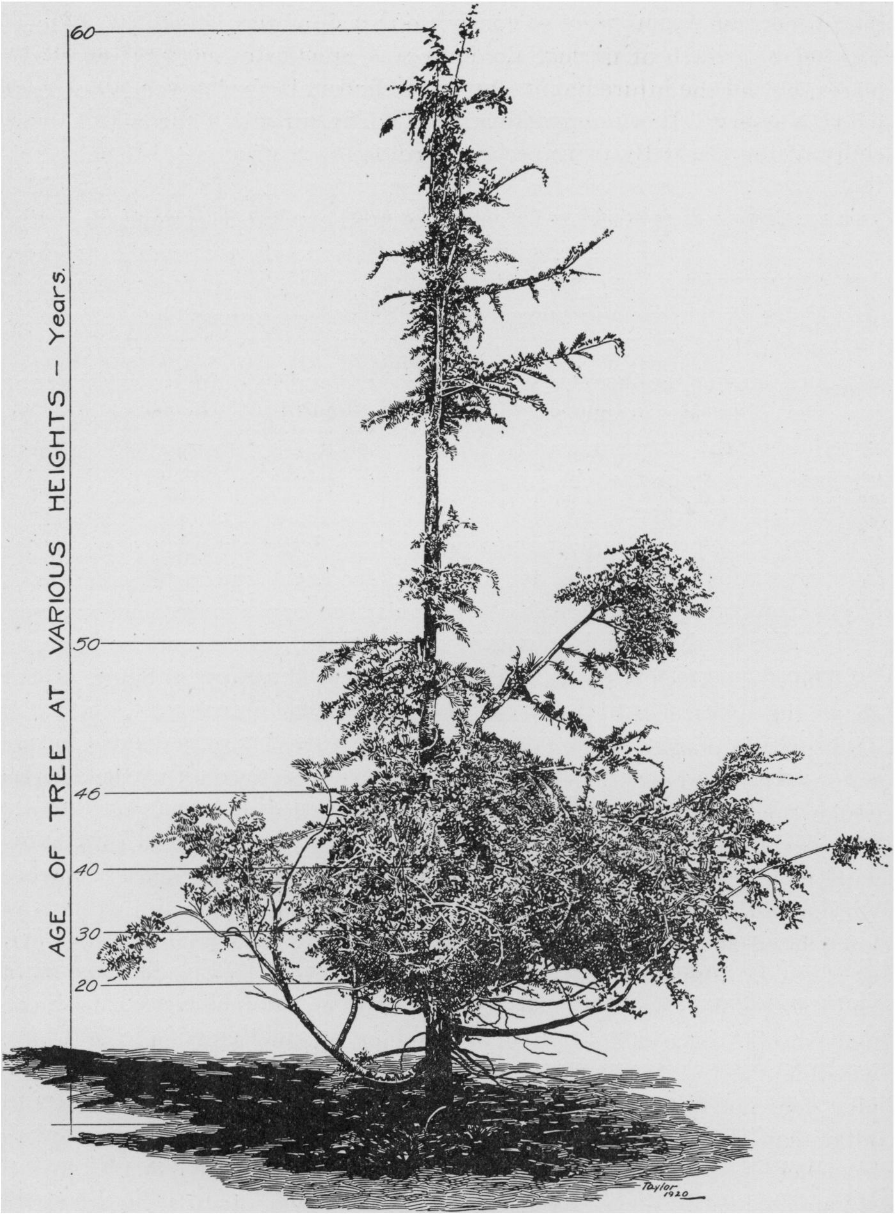
AGE OF TREE AT VARIOUS HEIGHTS - Years.
60
50
46
40
30
20
Taylor 1920

Fig. 1. A Douglas fir sapling held back by rabbits for 46 years showing rapid growth after growing out of reach of rabbits.

Basin Experiment Station. Although the latter is about 100 miles south of the former, the results were so consistent that they were combined in table 1. The height-growth of normal alpine fir was practically the same in the two places, but all the injured alpine fir was found in the vicinity of the Cottonwood Nursery. It was impossible to find any injured alpine fir in the vicinity of the Great Basin Experiment Station.

TABLE 1. *Effect of snowshoe rabbit injury on height growth of Douglas fir, white fir and Alpine fir*

Age	Height					
	Douglas fir		White fir		Alpine fir	
	Normal	Injured	Normal	Injured	Normal	Injured
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
10......	.6	.6	.6	.6	.6	.6
20......	1.9	1.4	1.8	1.8	1.8	1.6
30......	5.1	2.5	3.8	3.0	4.0	2.8
40......	9.8	3.7	7.0	4.6	8.8	4.2
50......	14.4	6.4	12.5	7.4	16.8	6.0
60......		10.8	26.0	13.5		9.2
70......		15.6				

The effect which is shown in table 1 is clearly illustrated in figure 1, which shows the appearance of a severely injured Douglas fir.

Injury to planted trees varies to quite an extent. In general it is more serious with the pines than other species, largely on account of the fact that young pines have but one leader while the spruce and Douglas fir either have several leaders or are capable of growing side branches into leaders with more ease than the other species. There are differences, however, varying with the different species of pine. Lodgepole pine and western yellow pine usually send out one shoot at the point of injury, although as many as three or four may occasionally appear. These shoots develop rapidly and the tree does not die unless the top is bitten off repeatedly. Lodgepole pine shows remarkable recovery following rabbit injury at the Cottonwood Nursery. At the Great Basin Experiment Station where lodgepole pine does not flourish as it does farther north, rabbit injury is more often fatal than in the case of western yellow pine, and the production of side branches is rather difficult. Austrian pine sprouts with difficulty and the stump frequently dies. Even in the Karst region of Austria, where this species is planted with great success, it is noted that if rabbits remove the leader before side buds are formed adventitious buds seldom appear and the stump dies.[1] After side buds are once formed, however, the tree usually recovers. Side buds are formed in two to three years in the Karst, but in Utah the growing season is so very much shorter that the formation of side branches is much delayed, leaving the species open to destructive attacks of rabbits for a very much longer time. Scotch pine, on the other hand, sends out a great many shoots, all of which are rather weak, and the tree grows into a small bushy form with no promise of ever developing properly. Douglas fir in particular, has a great many shoots, any one of which can become a leader, and since the rabbits rarely bite off all of the shoots, this species is less likely to be killed or badly deformed than the pines. The reduction in height-growth is nevertheless very marked. The spruces are not injured as extensively as the other species. They also fail to recover promptly because the new sprouts do not develop rapidly and the lateral branches fail to take the place of the leader as effectively as they do in the case of Douglas fir. In Australia[2] where Douglas fir is easily grown, rabbits are very fond of nipping the leader of every Douglas fir and *Pinus laricio* they encounter, while they frequently pass *Pinus radiata*.

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[1] "Geschwind. Die Hasenschäden in Den Schwarzkiefernkulturen des Karstes." (Wien) Allgem. Forst u. Jagd Zeit'g. **38**: 159–160. 1920.

Plantations of western yellow pine, where the extent of damage has been studied with particular care, usually have been made in the oak brush type where conditions are very severe during the summer on account of the heat and dryness of the site. Most of the death is clearly due to these climatic causes. Investigations have shown that trees with small tops in relation to the extent of root have more chance of success in the oak brush type than trees with large tops, and, while it is difficult to prove, it certainly appears that in some cases at least the nibbling of the large and thrifty tops by rabbits has resulted in saving the tree in the hot summer period. A study of a plantation in the oak brush showed 19 percent of the trees injured by rabbits within two months after planting. During the summer 45 percent of the trees which showed rabbit injury died while of those uninjured 41 percent died, the difference between the two being practically negligible. On other plantations which were examined the results are very much the same. On one area which had been established for several years 3.5 percent of the trees died during the summer in which this study was made. None of the trees had ever been injured by rabbits. On another plantation 22 percent of the rabbit-injured trees died while among the uninjured the mortality was 7.8 percent. In general it must be admitted that as a factor causing high mortality in new plantations rabbit injury is secondary to climatic factors on such severe sites as the oak brush. On the other hand, the loss from climatic causes falls rapidly after the trees become established, whereas the injury on account of the rabbits is cumulative and increases from year to year until the trees are above the reach of these rodents.

At the present time, the writers are somewhat reluctant to suggest a method of combating rabbits over the entire Wasatch Range. However, in the past it was found absolutely necessary to afford some protection to the various plantations. The scattering of poisoned baits of alfalfa hay and of oats through the dense thickets of brush close to the plantations was the method followed.

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[2] Mackay, H., "Conifers in Australia." Australian Forestry Journal **2**: 266. 1919.

When done thoroughly after the ground was covered with snow it proved effective. However, all of the rabbits were not killed on the poisoned area, but the number was so reduced that the injury to the nearby plantations was reduced to an almost negligible amount. Some 45 rabbits were killed in this way in the immediate vicinity of the Cottonwood Nursery during the fall of 1916 and a somewhat smaller number during the three succeeding years. Two formulae for mixing poisoned bait, both of which were used with good success, are given below:

FORMULA I (U. S. BIOLOGICAL SURVEY)

Ingredients:

Water (boiling)	1½	pints
Strychnine	1	oz.
Saccharine	⅕	oz.
Soda	1	oz.
Dry gloss starch	2	tablespoons
Syrup (Karo preferred)	½	pint
Oats (clean)	15	quarts

Method of Mixing.—Mix the strychnine, saccharine and soda, dissolving the mixture in a little hot water. Dissolve the starch in a small amount of cold water, add it to the boiling water and cook until a thin clear paste is formed, then take from the fire and add the strychnine, saccharine and soda mixture and also the syrup. After stirring well, the liquid is applied to 15 quarts of clean oats, mixed until each kernel is coated. The oats should stand at least 12 hours before being distributed. When dry, add 7 quarts of oats and distribute in small piles (about a cupful in a place) along the rabbit trails.

FORMULA II

In the second formula alfalfa hay of a good quality is used as a bait, which is prepared as follows: one ounce of strychnine and ⅕ ounce of saccharine are thoroughly dissolved in one gallon of hot water and sprinkled slowly over 15 pounds of hay. The hay must be turned over frequently until thoroughly saturated and all the water absorbed. A large galvanized tub makes a good mixing vessel. Several hours after mixing, the hay is tied in 50 to 75 small bundles and distributed along the rabbit trails, preferably by tying them to the brush 8 or 10 inches above the surface of the snow so that they will not be covered before they have served their purpose.

It is useless to start poisoning operations before permanent snow covers the ground, since the baits will remain untouched while there is still an abundance of native vegetation available for food. In conducting work of this kind it is necessary to follow up the line of baits every few days to ascertain the results and distribute additional baits wherever needed.

The main difficulty in rabbit control work lies in the fact that, although the rabbits may be temporarily eradicated from an area, others will drift in from adjoining territory and soon restock the area. Therefore, the larger the area poisoned, the more effective the work. For the protection of extensive plantations this is, no doubt, the proper method to follow and in the future it may be necessary to resort to it in the protection of natural reproduction. For the protection of small, isolated plantations, especially if absolute protection is necessary or desired, fencing seems to be the only effective remedy known at the present time. Hutchins[3] states that in England, France and northern Europe, the rabbit is a constantly recurring trouble to foresters, and that wire-netting fences and rabbit destruction are necessary. The yearly cost of protection against rabbits in the fine forest of Compeign near Paris, is stated at 1,000 pounds sterling. Hutchins suggests an experiment in rabbit control through the introduction of South African wild cats on some island between Tasmania and the mainland of Australia.

Summary

1. Snowshoe rabbits are present in large numbers throughout the Wasatch Mountains.

2. Their food during the winter months consists principally of the buds and tender twigs of conifers, and they are therefore a serious menace to natural reproduction as well as to plantations.

3. In localities where rabbits are numerous, injury from this cause very materially reduces height-growth of coniferous seedlings and saplings.

4. With the destruction of a large number of coyotes—the principal natural enemy of rabbits—there has been a considerable increase in the number of rabbits and a corresponding increase in the damage to conifers.

5. Poisoning is the most feasible method of rabbit control on large areas. Fencing is necessary where absolute protection is desired on small areas. Formulae are given for preparing poison bait.

[3] Hutchins, D. E., "A Discussion of Australian Forestry, with Special Reference to Forestry in Western Australia," pp. 403–408. Perth, 1916.